AUG 14 1936

Volume 22 August, 1936 *Number 8*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Protected Lubrication in Iron and Steel

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICATION RECOMMENDATIONS FOR *steel mill* EQUIPMENT

BLAST FURNACE EQUIPMENT

Motor Bearings		TEXACO Nabob or Aleph Oil
Car Wheel Journals		TEXACO Black Oils or TEXACO Car Oils
Trolley Bearings and Line Shafting	Winter Service	TEXACO Cup Grease No. 1
	Summer Service	TEXACO Cup Grease No. 3
Wire Rope		TEXACO Crater Compound No. 0 or No. 1
Gears	Winter Service	TEXACO Crater Compound No. 0 or No. 1
	Summer Service	TEXACO Crater Compound No. 2, No. 3, or No. 5

MIXERS

Motor Bearings	TEXACO Nabob or Aleph Oil
Bearings of Rollers	TEXACO Black Oils
Roller Tracks	TEXACO Black Oils
Gears	TEXACO Crater Compounds according to design

BESSEMER CONVERTERS

Hydraulic Plunger Mechanisms		TEXACO Axle Grease Graphite
Steel Cranes—Gears and Racks	Winter Service	TEXACO Crater Compound No. 0 or No. 1
	Summer Service	TEXACO Crater Compound No. 3 or No. 5
Bearings		TEXACO Black Oils or TEXACO 629 Oil

OPEN HEARTH FURNACES

GAS PRODUCERS	External Bearings	TEXACO Black Oils
	Motor Bearings	TEXACO Nabob or Aleph Oil
Gears	Winter Service	TEXACO Crater Compound No. 0 or No. 1
	Summer Service	TEXACO Crater Compound No. 3 or No. 5
FURNACES—Door Plungers		TEXACO Axle Grease Graphite
CHARGING MACHINES AND LADLE CRANES	Journals	TEXACO Black Oils
	Motor Bearings	TEXACO Nabob or Aleph Oil
Shaft Bearings	Winter Service	TEXACO Cup Grease No. 1
	Summer Service	TEXACO Cup Grease No. 3
Gears	Exposed	TEXACO Crater Compound No. 3 or No. 5
	Bath lubricated	TEXACO Crater Compound No. 0 or No. 1
INDUCED DRAFT FANS—Shaft Bearings		TEXACO Pelican Oil

ELECTRIC FURNACES

Motor Bearings		TEXACO Nabob or Aleph Oil
Gears	Winter Service	TEXACO Crater Compound No. 2 or No. 3
	Summer Service	TEXACO Crater Compound No. 3 or No. 5
Miscellaneous Bearings		TEXACO Black Oils

STRIPPING CRANES

Bearings	TEXACO Black Oils or TEXACO 629 Oil
Gears and Wire Rope	TEXACO Crater Compound No. 1 or No. 2
Plungers	TEXACO Crater Compound No. 0 or No. 1

INGOT AND LADLE CARS

Plain Journals	TEXACO Car Oils
Roller Bearings	TEXACO 650 T Mineral Cylinder Oil or TEXACO Marfaks

POWER EQUIPMENT

BLOWING ENGINES—Steam Cylinders	TEXACO Pinnacle Cylinder Oil or TEXACO Leader Cylinder Oil

Continued on inside back cover

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Published by

The Texas Company, 135 East 42nd Street, New York City

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Vol. XXII August, 1936 No. 8

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Protected Lubrication in Iron and Steel

LUBRICATION in the iron and steel industry became of supreme importance with the development of mechanized handling of raw materials and methods of continuous production. Moving parts had to be protected. It was unit lubrication, however, applied to bearings in the form of heavy grease or oil, and gears as a relatively non-fluid gear lubricant, noteworthy for its ability to stick, resist pressure and temperature.

As the industry developed, along with the automotive industry especially, steel shapes and plates of more precise dimensions were required. So a state of flux arose in the design of steel mill machinery; operations became more synchronized, clearances were reduced, gears were more and more enclosed, and machines in general designed for protection of their moving parts. Automatically this protected lubrication. No longer was it necessary to consider contamination of oils and greases as a probability. It became but a possibility. Hence, one could study with greater confidence those specific physical or chemical properties which must be considered in light of the operating conditions.

Considerable progress was made in advancing this idea of more protective lubrication of steel mill machinery during the recent period of relative inactivity, which permitted designing and operating engineers to give more careful thought to the development of the most practicable means of lubrication and methods of protecting both lubrication and machine elements during operation. Cooling today is a most important factor. The relation of cooling to circulating oil lubrication has gained much consideration for this method of lubrication, with the added protection of suitable means for purification or continuous filtration.

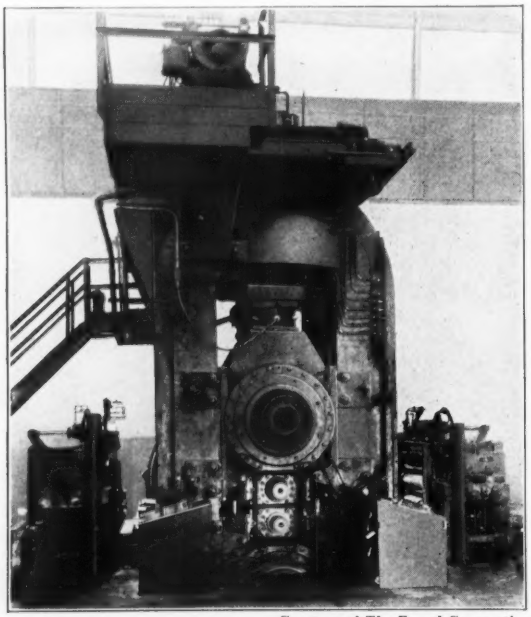
First cost, of course, has had to be carefully weighed against expected economies over an extended period of service. In the opinion of authorities, many mills could afford to virtually disregard first cost of an oil circulating system coupled with the increase in cost of using a considerably greater initial volume of high grade oil, in view of the resultant more positive operation which experience to date has proved can be expected. Increase in useful life of bearings and gears, reduction in maintenance and repair expense, including reduction in the labor attendant upon lubrication, have been other items which gave an appeal to circulating oil lubrication.

While oils have lent themselves more readily to circulation through suitably designed lubricating systems than greases, the latter are, of course, admirably adapted to certain types of steel mill bearing lubrication, especially under heavy duty conditions.

As a result, lubrication by means of centralized pressure can involve either grease or oil, according to the design of the lubricating system. The features of any such means of lubrication, under adequate pressure, include:

1. Positive delivery of lubricant to insure maintenance of a sufficient film between the bearing surfaces.

2. The exclusion of non-lubricating foreign matter.
3. Decided economy of lubricants.
4. A minimum of hazard in handling or filling.
5. Minimum supervision.



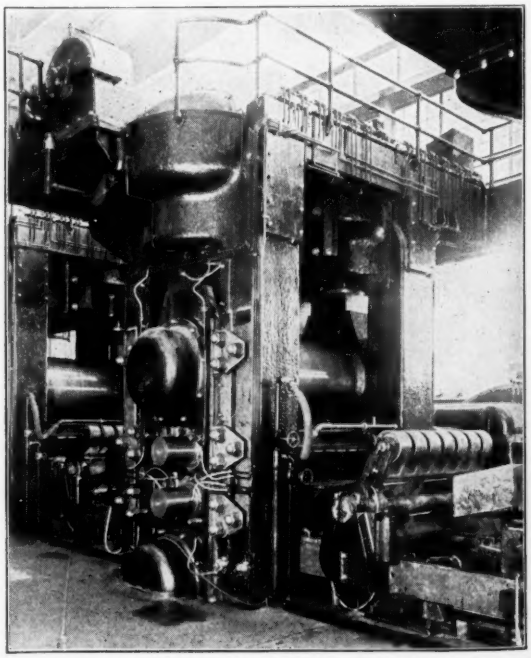
Courtesy of The Farval Corporation

Fig. 1—End view of a Four High "United" Cold Tin Plate Mill showing part of the piping and fittings essential to the Farval system of lubrication.

Studies relative to the adaptability of centralized control were first directed towards greases, for lubricants of this nature had grown up with the industry. The exposed nature of roll neck bearings, table rolls, and the wide variety of other heavy duty bearings, was largely responsible for this trend, heavy greases being most tenacious and better able to remain adjacent to the parts to be lubricated with consequently less loss. It was highly essential to prevent this latter as far as possible, for loss meant dripping and introduced a personal hazard which was contrary to all ideals of safety.

A number of ways have been developed to enable control of greases and their delivery to the various points of application. In all, power in some form or other is customarily used. Where positive piston displacement types of metering valves are employed at each point to be lubricated, hydraulic power has been found to be especially adaptable as a means of valve control. In such a system either one or two lubricant supply lines can be connected to each valve according to the nature of the service. For heavy duty machinery, such as is encountered in the steel mill, dual lines are sometimes employed, each serving alternately to load the respective valves periodically with the right amount of lubricant, and to also discharge this to the bearings. Other systems require electric power or compressed air. Certain of these are designed to eliminate the necessity for springs, check valves or restricted port openings. Due to the fact that these systems operate under high pressure, any air in the system is soon exhausted by the measuring valves, and the positive delivery of a measured charge of lubricant is assured. Air pockets are affected by the body of the lubricant, becoming increasingly prevalent with heavy inert greases.

When pressure application of greases was considered, and later put into application, the manually operated grease gun was first used. It was simple, expedient and economical. Two noteworthy changes were effected in mill design and procedure as a result of this; i. e., improvement in bearing closure with marked extension of the roller bearing, and the use of lighter bodied greases. Both increased operating economies, the former from the viewpoint of reducing leakage and improving working conditions, the latter by reducing the amount of power required for mill operation. These markedly offset the increased costs incident to more mechanical methods of lubrication and the necessity for more carefully refined lubricants.

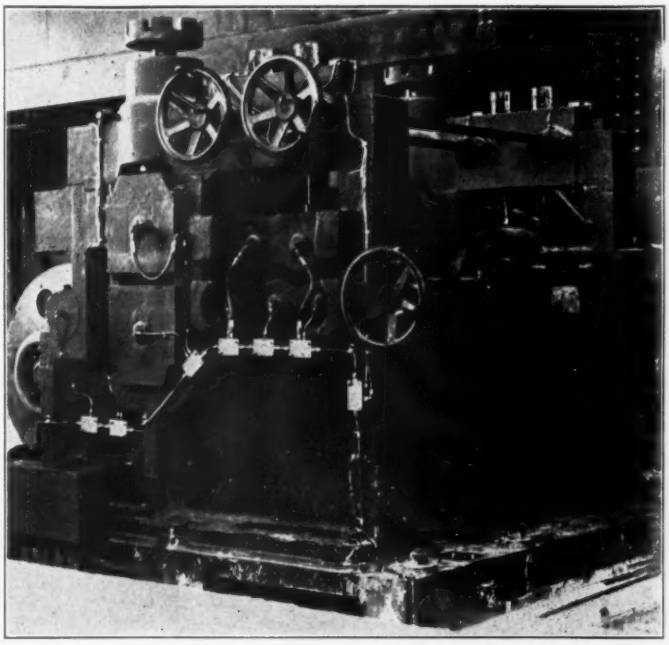


Courtesy of R. M. Gordon & Company

Fig. 2—A "United" Four High Finishing Stand showing piping essential to the Gordon lubricating system. Note manner in which roll necks are housed.

The pressure gun can be designed either as a

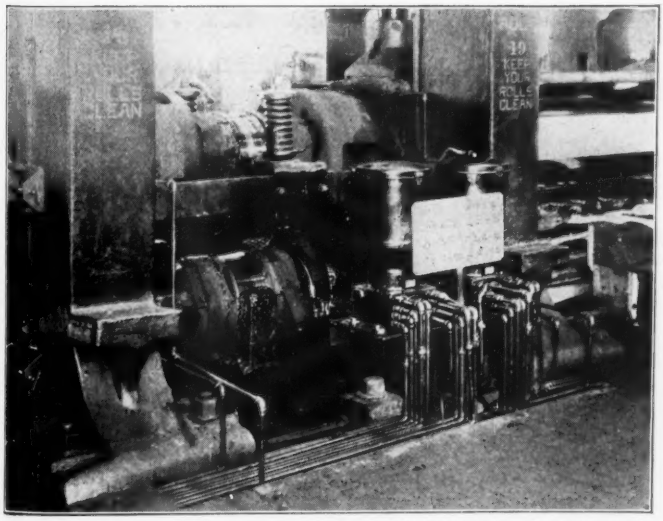
directly connected unit, thereby becoming an integral part of the system, or a portable unit can be used. The portable gun is of decided value as a general piece of plant lubricating equipment, inasmuch as it can be applied quite as effectively to individual lubricators as to a centralized system. It can furthermore be used with the spring type of cup with equal dependability. As a general rule, by using a grease cup wherein the spring tension is comparable to the orifice at the outlet, suitable control over the flow of grease from the cup can be maintained. Greatest pressure is exerted, therefore, when the cup is filled, decreasing as the spring expands and the lubricator becomes discharged. The amount of grease in the lubricator, however, can be noted by observation of the indicator attachment. Refilling is also a simple matter. Usually all that is necessary is to attach a grease gun to the fitting located in the base of the cup and work the discharge of the gun until the indicator shows the cup to be filled. There is no necessity for removal of the cover, consequently there is more positive assurance that the grease charge will not become contaminated by dust or dirt.



Courtesy of Trabon Engineering Corporation

Fig. 3—A Cold Strip Processor and Leveller equipped with the Trabon system of pressure lubrication. Piping details can be plainly observed.

Normally such an installation will require but little power, unless heavy-bodied inert grease is to be handled. The average hand pressure gun should, therefore, deliver any amount of grease required (up to its capacity) with little effort and loss of time. Where heavier bodied greases are used, however, or where long runs of piping are necessary, it will be preferable to consider compressed air or electric power for grease gun operation and the more positive development of higher pressures. One should never regard such pressures as being transmitted directly to bearing clearances or the lubricant therein; normally it must be translated by the grease in the distribution lines. In fact, when using the grease gun in connection with a positive feed lubricator the pressure as developed by the gun must first be converted to mechanical energy by doing work in compressing the spring in the grease cup. From this point on lubrication is automatically maintained by the mechanical action of the spring upon the adjacent plunger which bears upon the grease charge to force it to the bearing clearances.



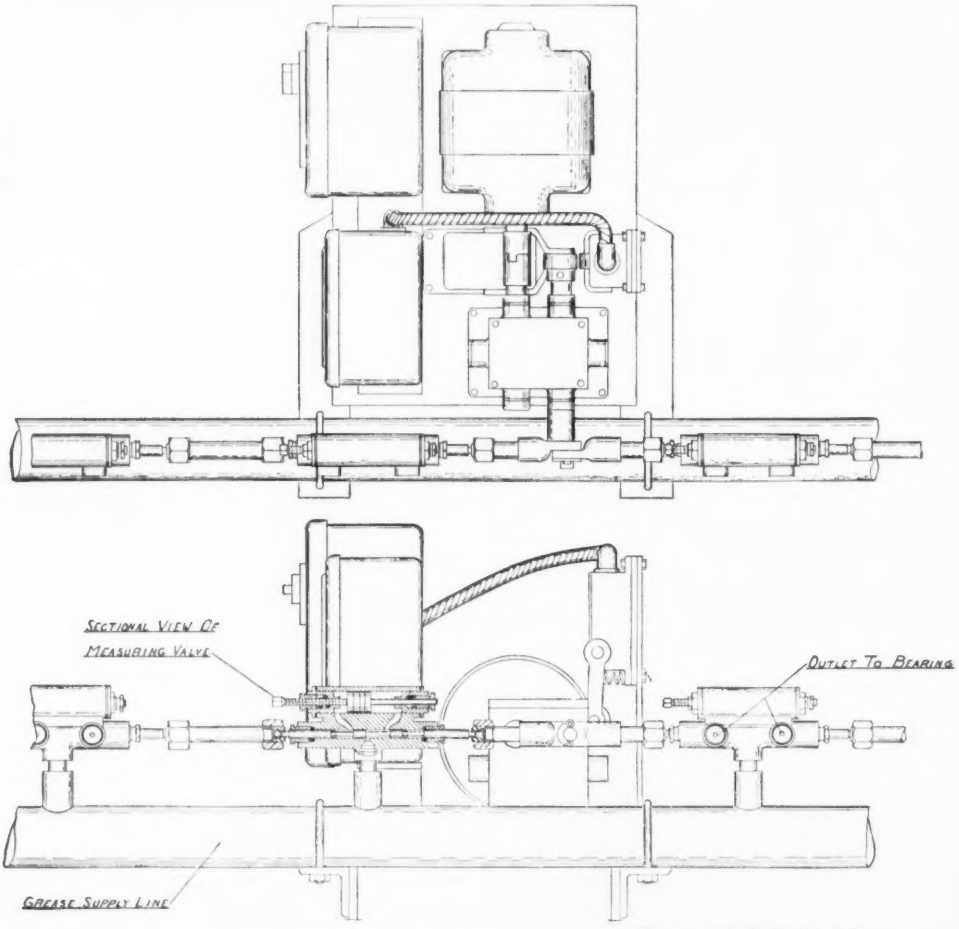
Courtesy of United American Bosch Corporation

Fig. 4—Installation of two Bosch Grease Lubricators of the KP-30 type supplying automatic force feed lubrication to nine steel rolling mills..

DIRECT POWER SYSTEMS

Pressure grease lubrication through the medium of cup application is not always practicable however; collective lubrication through manifold equipment is frequently regarded as more preferable, and conducive to more uni-

form distribution of the lubricant. Furthermore, direct power systems are better suited to service where comparatively high pressures of application are desirable. In connection with pressure, however, one must remember that some greases may separate when subjected to constant pressure. Consideration of this possibility is, therefore, advisable when selecting a grease for any such system. The science of grease manufacture has developed means of preventing separation which always warrants a somewhat higher first cost.



Courtesy of R. M. Gordon & Company

Fig. 5—Arrangement of valves and valve tripper for the Gordon system of lubrication. This is electrically operated.

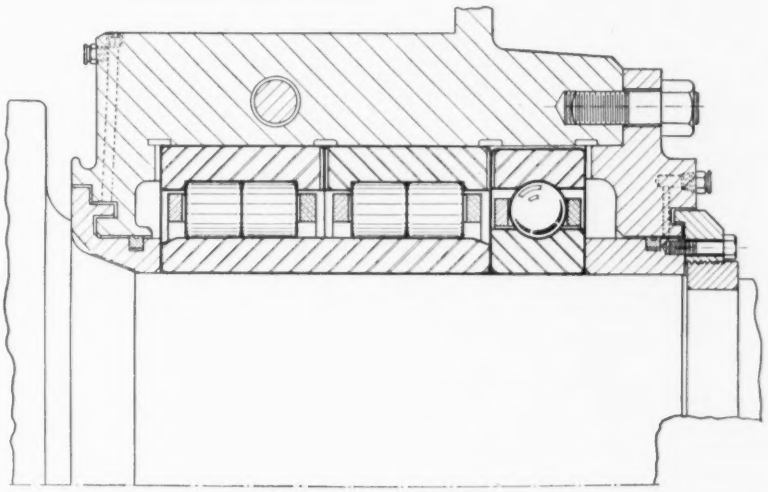
In the application of such products positive and complete cleaning of bearing grooves and clearance spaces prior to re-lubrication will be of primary importance, especially where conditions of operation may be conducive to entry and accumulation of dust, dirt or other non-lubricating foreign matter. The value of pressure in forcing out old grease and dirt from certain types of bearings has been definitely proved. Judgment is necessary, however, in determining when this has been completely accomplished and when to shut off the pressure and cease forcing in new grease. If properly done, such a method of lubrication is decidedly economical. On the other hand, if the operator is careless, unobservant, or continues to apply lubricant beyond the necessary extent, he will not only waste grease, but may also cause development of a sloppy condition around the bearings. A slight bulge of grease, especially around the end of a sleeve-type bearing, will usually indicate that complete re-lubrication has been accomplished.

Grease Gun Design

For individual machine service the unit type is perhaps the most suitable device, due to its ability to operate by means of hand or foot pressure. Grease guns of the hand pressure type will usually be capable of developing several thousand pounds pressure per square inch. They are practicable either with or without hose connections, according to the location of the part to be lubricated and the

type of fitting for which they are designed. Furthermore, pressure can be applied either before or after attachment. A frequent method of developing pressure in a grease gun is to force down a suitable plunger by means of a threaded stem which screws into a bushing in the head. Another type of gun involves pumping action by means of the handle and a suitable pressure-retaining device.

Where pressure is to be developed before attachment of the gun to the fitting, a suitable check valve must be installed in the tip. In certain guns the act of attachment opens this valve and automatically permits passage of lubricant to the bearing clearance. This sudden application of fresh grease under adequate pressure is of distinct advantage in clearing a bearing of used lubricant. Regardless of the actual means of application, however, use of the pressure gun in virtually any form requires a certain amount of manual handling. The gun itself must be moved about, flexible hose must be handled, fittings must be wiped clean before attachment of the hose or gun connection, and finally the gun must be put into operation. All this requires time, care and good judgment. The latter is especially essential in determining when a bearing has been sufficiently re-lubricated. Recent studies of certain roller bearing designers have indicated that the amount of grease delivered to a bearing can be controlled by judicious installation of a suitable vent in the upper part of the housing which enables efflux of grease after a certain amount has been charged.

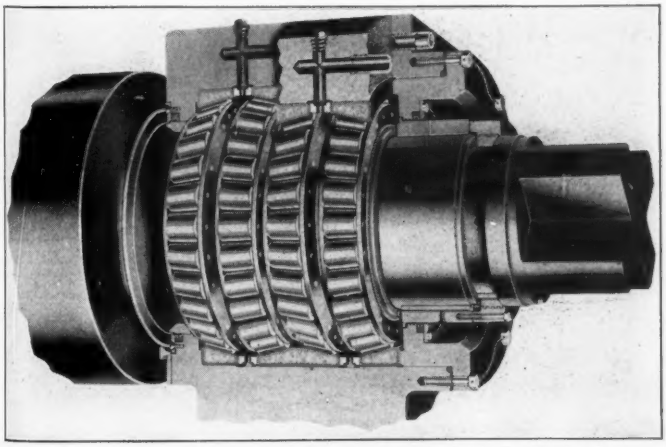


Courtesy of Norma-Hoffmann Bearings Corporation

Fig. 6—Details of the back up roll of a Four High Mill equipped with Norma-Hoffmann ball and roller bearings designed for grease lubrication.

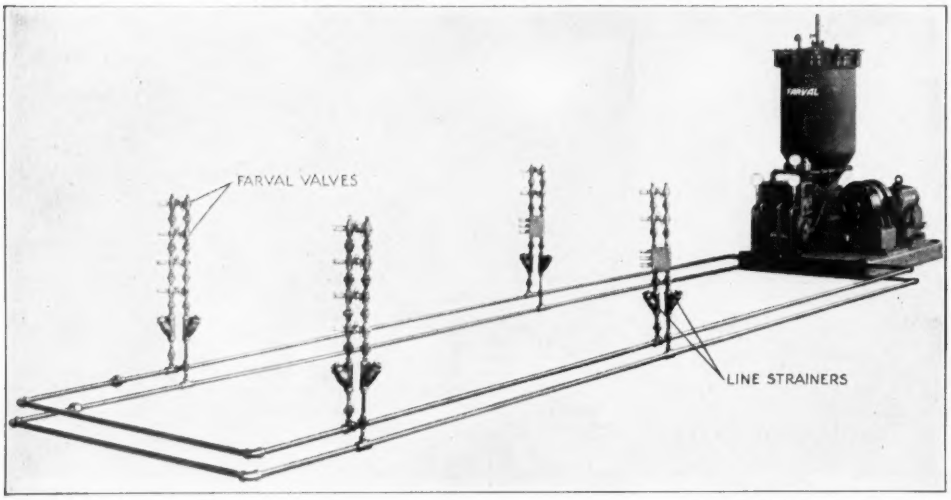
Concentration of pressure gun fittings at a central panel or point of control will also aid in reducing the labor essential to lubrication. This has been accomplished with such success that today it can be safely stated that not only in the steel industry, but also in other phases of production where heavy duty machinery is involved, centralized pressure grease lubrication is a practicable and comparatively economical procedure. It is distinctly advantageous in enabling reduction of hazard by concentrating equipment in a safe location, and controlling grease flow to enable the most economical lubrication.

Rigid connection devices are designed to function with check valves in order to eliminate the necessity of relieving the pressure before detaching the gun from the fitting and to enable pressure to be raised before attachment, to overcome the possibility of twisting off the fitting. The direct or swivel jointed connection also does away with the possibility of leaks in the flexible hose. These factors are especially important where bearings are to be "started" or cleared of grease which has been allowed to remain too long in the grooves or clearance spaces and consequently become gummed, caked and mixed with dirt, or other non-lubricating matter.



Courtesy of The Timken Roller Bearing Company.

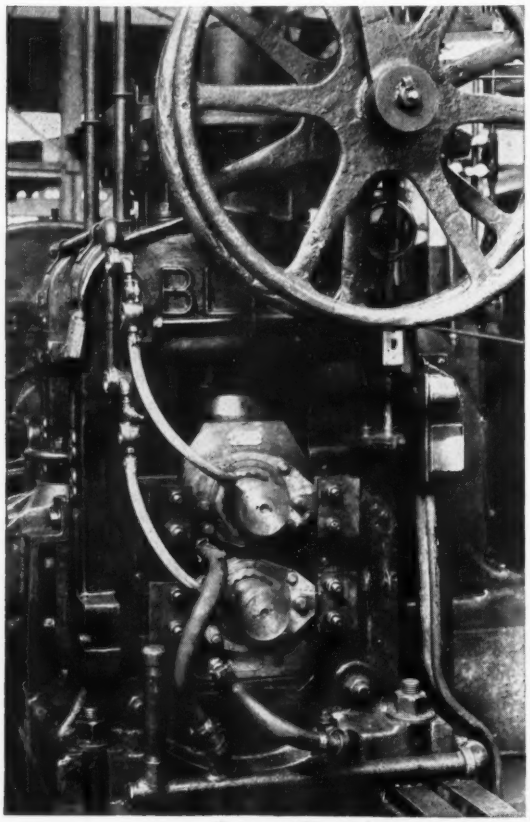
Fig. 7—Essential details of the Timken heavy duty steel mill bearing designed for roll neck service.



Courtesy of The Farval Corporation

Fig. 8—Piping details of the Farval "Dualine" System. This equipment uses a piston displacement measuring valve to control the delivery of lubricant to each bearing.

The mechanical or power lubricator of considerably greater grease capacity than the hand or foot pressure gun, is particularly adaptable to steel mill service. In general, such lubricators are capable of holding 50 pounds of grease or more. The smaller capacity guns are chiefly of the hand service type; that is, after pressure is developed by power, the grease is discharged by the operation of a pump handle or lever. A ball or check valve at the base of the pump automatically closes at the end of each stroke to retain all pressure that may have been built up. To insure efficient operation this check valve must be inspected at frequent intervals to insure cleanliness.



Courtesy of Morgan Construction Company

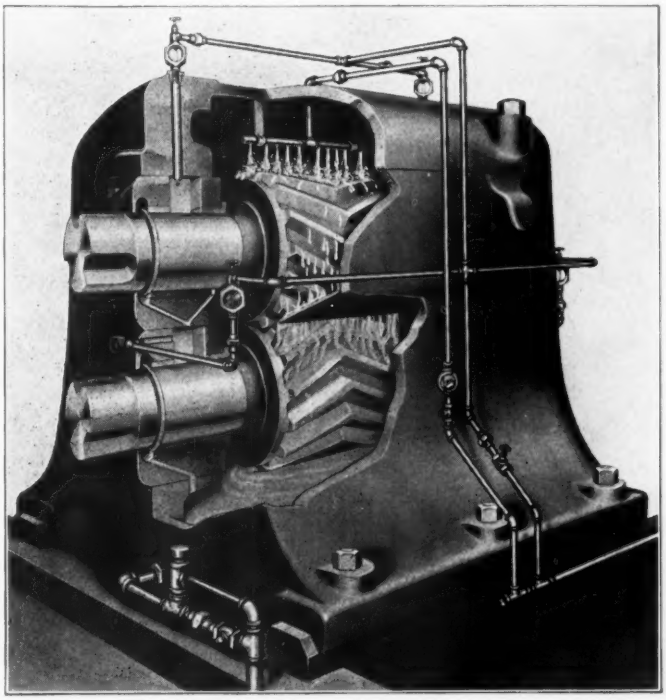
Fig. 9—Application of Morgoil Bearings to a Two High Cold Rolling Mill. Note the supply and drain lines through which oil is circulated continuously to maintain an unbroken oil film between the bearing surfaces.

In such equipment pressures of from 1000 pounds upward are readily developed. These pressures are sufficient to handle the usual grades of grease which are applicable to steel mill service where normal pressures and bearing size prevail. Where heavier or more viscous grades of lubricants are used in considerable volume the electric or pneumatic compressor is widely employed. Such lubricators are usually of higher capacity than the hand service type, in certain cases holding as much as 400 pounds of lubricant. In this latter capacity a multi-lead discharge manifold is frequently installed to enable the lubrication of a number of points simultaneously. Such compressors can be either electrically driven, or designed to take their air from an adjacent compressed air line. In other respects the principles of design of the power lubricator or compressor are much the same as those involved in the hand service type of device. In any such device, however, the size of the grease distribution lines is important. Normally a minimum of ½-inch diameter is regarded as good practice, using somewhat larger piping for heavier greases.

CIRCULATION OF FLUID OILS

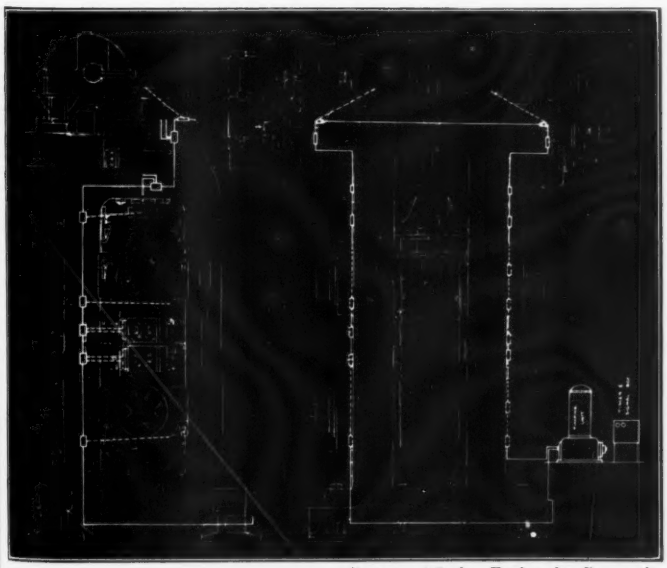
The advantages incident to continuous circulation of comparatively fluid oils became more pronounced with the extension of oil-tight housings to certain types of steel mill gears, and the design of lubricating systems capable of serving both gears and bearings with the same oil. Installations of this type are comparable to the reduction geared steam turbine, involving operating conditions which require oils of similar characteristics, though usually of somewhat heavier body, ranging in viscosity from around 800 to 2300 seconds Saybolt at 100 degrees Fahr. Gear design has, of course, been an influencing factor in this regard; improvement in tooth cutting especially with respect to bevel units having been studied in the interest of obtaining higher speeds with reduced wear and less noise.

Circulation of fluid oils under uniform pressure conditions to such elements was found almost immediately to be conducive to these requirements, and helpful in reducing operating temperatures through the cooling effect of an excess of fresh cool oil. As a result a variety of combinations have been worked out, ranging in simplicity from the unit type of gravity feed system to those multiple power devices whereby an entire series of rolling mills can be served by oil under the same constant pressure. The extent to which entirely automatic operation should be approached in this regard has been subject to considerable discussion. Certain authorities feel that the unit idea whereby each mill is designed as an individually lubricated unit, will reduce the possibility of extended difficulties should faulty circulation develop anywhere in the system.



Courtesy of S. F. Bowser & Co., Inc.

Fig. 10—Cutaway view of a set of steel mill gears equipped with the Bowser system of automatic circulating oil lubrication. Manner in which oil is directed to the gear teeth and led to the bearings is plainly indicated.



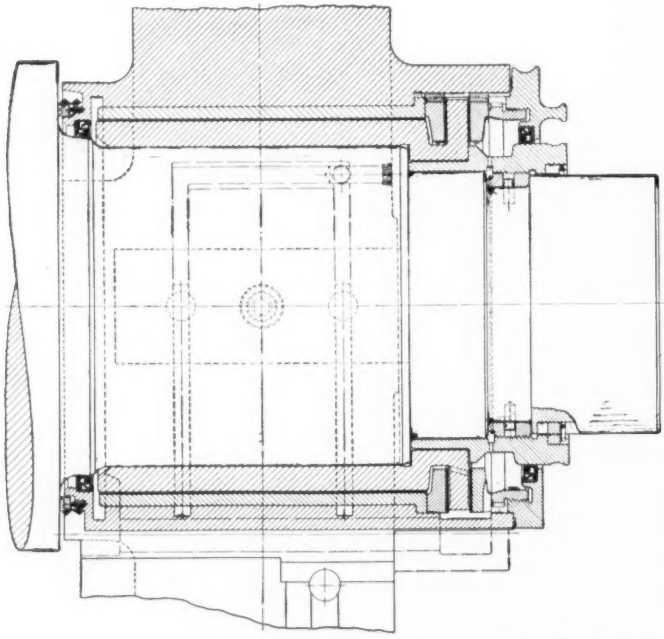
Courtesy of Trabon Engineering Corporation

Fig. 11—Elevation view of the piping arrangement essential to a Trabon steel mill system of pressure lubrication.

Gravity circulation of oil is the more simple and is frequently preferred. There is no doubt but that it will reduce intricacy in construction and the necessity for costly automatic controls; on the other hand, it is limited in regard to the amount of pressure available. Where this may be low, due to plant conditions, it may affect the viscosity of the oil which should be used. Normally with increase in pressure, the viscosity can be somewhat reduced. This reduction in body of the lubricating film is compensated for by the added volume involved and pressure under which the oil is delivered.

Relative fluidity must, of course, always be carefully studied. As measured by the vis-

cosity and pour test, the fluidity, especially at low temperatures, becomes highly important in conjunction with the pressure available.



Courtesy of Morgan Construction Company

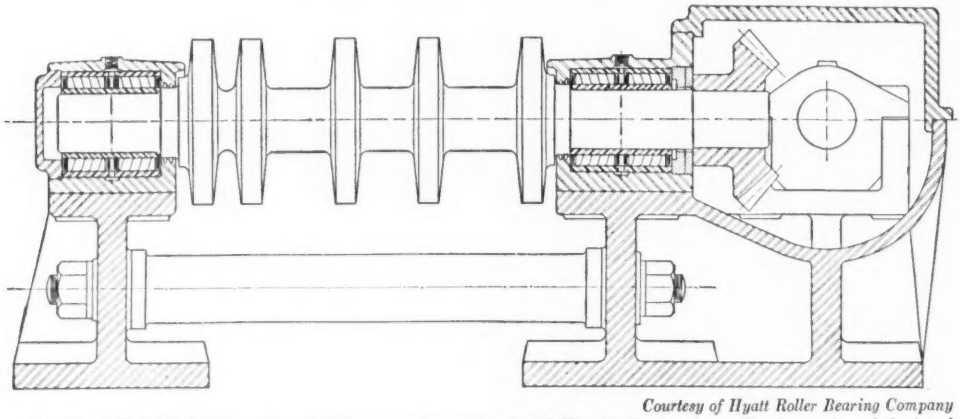
Fig. 12—Showing a Morgoil Bearing assembly. This device includes a heat treated, forged alloy steel sleeve which rotates with the roll neck and which is constructed with a flange at its outer end. The cylindrical portion of the sleeve is carried in a bushing lined with centrifugally cast bearing metal of special composition, while the thrust flange is placed between two stationary thrust rings having centrifugally cast facings of bearing metal. The outer surface of the bearing sleeve is ground to a mirror finish.

The pour test requires special consideration, for in cold weather or under low temperature starting conditions, the rate at which the oil will return to the settling tanks may be affected. Should it become too sluggish at any time, flow-off from a pinion housing or bearing might be impaired to develop backing up of the oil in the system. Furthermore, if any bearings are improperly sealed, oil might leak from the case. This would result in waste, also a sloppy condition on the operating floor.

Where viscosity or pour test are too high, the decreased fluidity may also develop marked increase in power consumption. This would prevail throughout the system, for not only would the circulating or oil delivery pumps be called upon to do extra work, but also the mill drives themselves might feel the extra duty demanded due to the increase in internal friction within the lubricant itself. Increase in the automatic nature of any such system calls for more careful consideration to these factors of pour test and relative fluidity. With extensive piping layouts and the possibility of abnormal friction losses occurring within the system itself, reduction in oil flow may result to a sufficient degree to require severe overloading of the pumps in order to keep the oil in the supply tanks at the proper level and deliver the required amount to the moving parts.

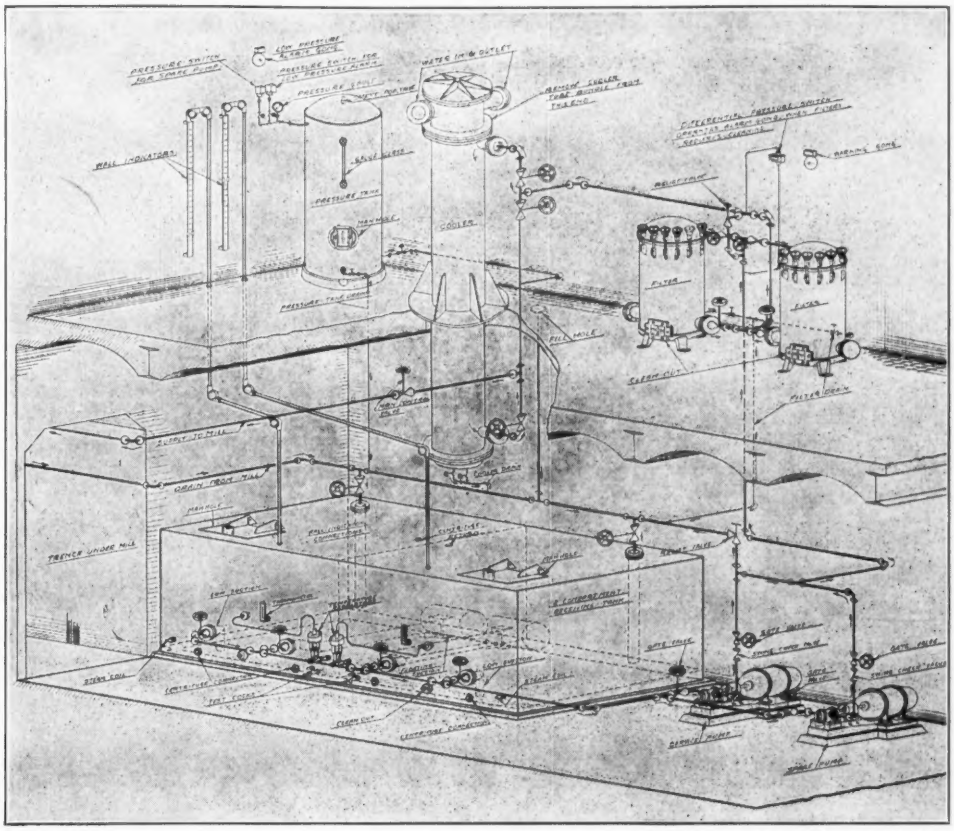
The Detriments of Water

Water, of course, may also become a factor in oil circulation as above. Water contamination of any oil in a pressure circulating system is objectionable, for it may seriously impair the lubricating ability and give rise to sludge accumulations which may prevent free flow of the oil through the lubricating system. For this reason the oil must be comparatively water-free at the beginning, and of good demulsibility; later, in service it must be kept in the same condition. In this respect the re-



Courtesy of Hyatt Roller Bearing Company

Fig. 13—A Plate Mill table roll bevel pinion mounting equipped with Hyatt roller bearings. Tooth reaction of the bevel pinion along the axis of the shaft is taken against a bronze plate. No separate thrust bearing is required.



Courtesy of S. F. Bowser & Co., Inc.

Fig. 14—Typical oil cellar equipment and piping arrangement for Morgoil Bearings lubricating system.

sponsibility devolves upon the designing engineer to plan for a water-tight system and the operator to keep it so. Prevention of entry of water into a circulating lubrication system adapted to an existing mill, however, may require the added cooperation of the master mechanic, the engineers who installed the lubricating system, as well as the lubricating engineer.

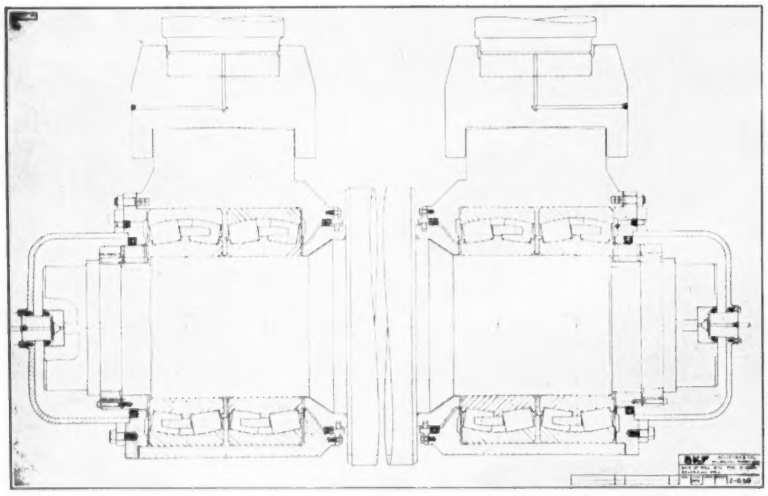
The amount of water which must be used on certain types of steel mill operations is considerable; it is one of the primary agents in heavy duty rolling mill service in eliminating scale formation. Much of this water will deluge the bearings and drives. After passing over the hot metal it is dirty and of sufficiently high temperature to work its way into the lubricating system almost regardless of the care in design. Furthermore, at a temperature of very nearly the boiling point, water will have a decided tendency to react physically with any oil with which it comes in contact, to cause formation of permanent emulsions which may be very difficult to break.

Fortunately, water traps and settling tanks have been found to aid materially in removing a considerable amount of such water before it has time to affect the oil. All points wherein water may gain entry into such a lubricating system should be carefully sealed as added insurance. This can be accomplished in many cases by caulking surface joints with oakum, and covering with molten lead. With bearings, however, attention should be directed to their original design, in order to provide for some recognized method of sealing, which will not impair in any way the free rotation of the shafts. The use of rawhide seals for this purpose has been studied extensively in this connection, likewise certain types of metallic seals.

RELATION OF OXIDATION TO DEMULSIBILITY

Inasmuch as lubricating oils for use in connection with steel mill pressure lubricating systems must be capable of ready separation from water, the demulsibility characteristic becomes a most important feature at the time of purchase. Demulsibility is a time element, being indicative of the ease with which oil-water emulsions will break and the rate at which the oil will free itself of entrained water. Demulsibility is directly related to emulsification. In other words, the ease with which an

oil emulsifies will be an indication of how readily separation can later be accomplished. This can be observed by shaking a well refined straight mineral oil in a bottle with a small amount of water, and then allowing it to stand. The respective liquids will separate, with a sharp surface of demarcation, and each will be comparatively clear. If, however, certain fixed oils or soaps are added to the mineral oil and the subsequent compound similarly agitated with water, the two liquids will separate more slowly, or they may remain mixed for an indefinite period. This intimate mixture of oil, or an oil compound with water is termed an emulsion.



Courtesy of S.K.F. Industries, Inc.

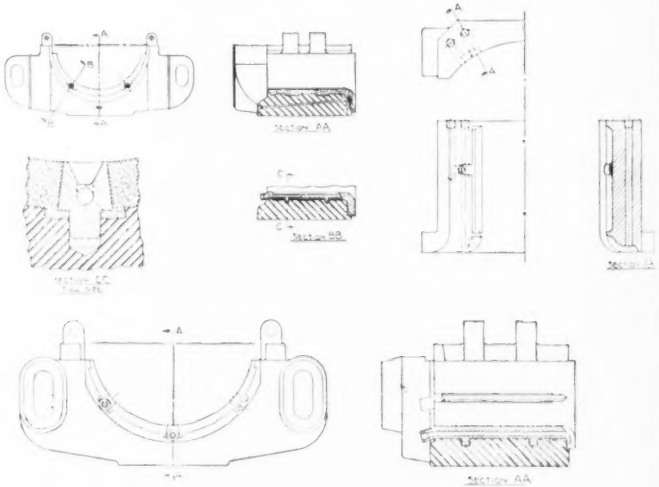
Fig. 15—Showing a typical application of S.K.F. self-aligning roller bearings to the back up rolls of a modern Hot and Cold Four High Mill. These bearings are mounted on the roll necks with a loose fit which permits them to be slipped on and off the neck. This is contrary to common practice in anti-friction bearing mounting where best results are obtained when the inner race is pressed on the shaft. Satisfactory performance, however, in steel mill service is obtained with the loose fit by providing adequate means for penetration of the lubricant to the bearing seat.

There is a definite relation between emulsification and sludge formation. Both, in turn, are accelerated by oxidation. When one considers that oxidation of petroleum oils is promoted by heat, air and water in the presence of certain metals, the possibility of its occurring in steel mill service is readily realized.

Sludge, in particular, must be given careful consideration. Today it is understood as comprising those insoluble or readily oxidized components in petroleum lubricants which are thrown down in the form of gummy accumulations. It is not necessarily the result of water contamination. In other words, oxidation will occur in practically any oil if it is subjected to oxidizing conditions. In fact, wherever particles of air and water are suspended or retained within the body of an oil to form an emulsion, in some cases only a slight elevation of temperature during circulating or agitation may be necessary to bring about an oxidizing reaction between the air and oil.

These conditions are normally so involved and so contingent upon one another that no one of them can be rightly claimed as being more detrimental than the other. On the whole, however, it may be stated that the extent to which oxidation will occur depends largely upon the refinement of the original oil. In other words, certain petroleum hydrocarbons will probably oxidize more readily than others. Logically, modern refinery practice is, therefore, directed towards the removal of these components by careful and accurate treatment.

Oxidation, furthermore, is accelerated especially by brass, bronze, iron or other foreign matter, such as dust and dirt. In fact, in an already emulsified oil foreign matter of this nature is regarded as being the co-partner of oxidation in producing the resultant insoluble



Courtesy of The Farval Corporation

Fig. 16—Showing two methods of grooving bearings on a reversing type of mill. In both types an independent lead is used to deliver grease to the thrust collar apart from the radial surfaces.

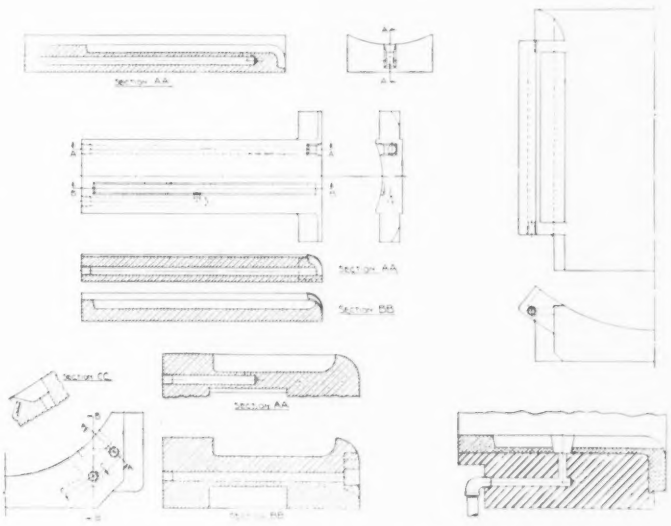
sludges so detrimental to proper lubrication.

It is believed by some that if emulsification is prevented, sludging will be greatly lessened. But emulsification involves only oil and water. It would, therefore, seem logical to consider foreign matter, or the catalyzers such as metallic particles which promote oxidation, as an equal detriment.

Emulsions alone are certainly not so viscous, adhesive and generally objectionable as insoluble sludges which frequently clog oil passages, congest the oiling system and generally reduce the lubricating quality of the oil.

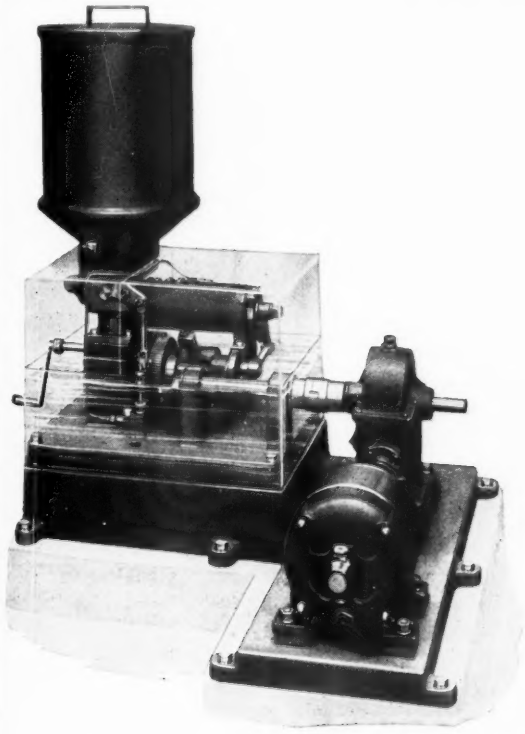
The natural procedure is, therefore, to reduce the effect by removing the cause as far as possible; in other words, by purifying the oil during operation to a sufficient degree to keep down the percentage of water, emulsion and foreign matter. The latter can also be prevented to a considerable extent by using steel piping and fittings throughout the oiling system, for steel has the least tendency to chip, corrode or otherwise contaminate the oil with metallic particles as it passes through the lubricating system.

Where breakdown in an oil has occurred, it will interfere with the separation of contaminating foreign matter. As a consequence, this latter will exercise its catalyzing effect on further oxidation in the bringing about of permanent sludges. It must be assumed that the presence of a certain amount of water and other impurities is a certainty. As a result, emulsions and sludges will be formed in the average steel mill oiling system. Effective oil purification should bring about the removal of these before their proportion becomes dangerous. From a constructional viewpoint, therefore, the oiling system should be so designed as to permit of ready separation of impurities from the oil by means of the reconditioning apparatus. Where the oil is in a sufficient state of purity, separation from water will normally occur comparatively readily, for the emulsion caused by agitation will be of relatively temporary character.



Courtesy of The Farval Corporation

Fig. 17—Illustrating various other methods of grooving smaller types of steel mill bearings.



Courtesy of Hills-McCanna Co.

Fig. 18—Details of a Hills-McCanna mill type grease pump showing in phantom the respective location of the operating parts. Note that these latter run in a bath of oil.

GEAR INSTALLATIONS

In addition to pressure lubrication of steel mill gears in conjunction with bearings using comparatively fluid oils, means have also been devised for automatic application of higher viscosity gear lubricants under pressure. In this way collective lubrication of certain types of exposed or semi-enclosed reduction gears is practicable using the same types of lubricants as adapted to bath installations. The assurance of positive, cleanly and economical application of lubricants to gear teeth is often a problem. This will be particularly true where

gears are exposed, or but partly enclosed, for in such installations there will always be a tendency for the lubricant to be thrown off by the action of centrifugal force. For this reason direction of rotation must be studied. In other words, certain types of lubricants are only applicable to down-meshing gears with any degree of success. With up-meshing gears the frequent necessity for application of such products as the teeth pass out of mesh will result in their being thrown off during subsequent rotation, although this will depend somewhat upon the viscosity and adhesive characteristics of the product used. Where application or re-lubrication is to be done by hand, these characteristics must be given very careful consideration, otherwise not only may the gear teeth suffer, but also a sloppy condition may prevail, due to dripping or throwing. To prevent all this, gears are housed or guarded wherever practicable. In addition, machinery builders have given careful study to development of means for automatic lubrication.

The simplest way to assure of maximum protection is to enclose at least the lowermost parts of the gears in an oil-tight housing, and provide for bath lubrication. This, however, does not obviate the possibility of some excess of lubricant being carried out from the bath to be perhaps thrown off from the teeth during the course of rotation. This will be especially possible if too light a product is used, or if it is not sufficiently adhesive to stick to the tooth surfaces. Where means are provided for constant delivery of gear lubricant to the teeth as they pass into mesh, in about the right amount to maintain lubrication, loss of lubricant can be materially reduced.

Pressure has been developed as being a practicable means of accomplishing this. It may be mechanical and dependent upon the operation of the machine itself, or the lubricating system may function independently, being power operated. Adaptation of the mechanical drive to large, heavy duty rolling mill gears will frequently not be practicable. Here the intensity of the service and the volume of lubricant to be handled will require the use of independently operated compressed air, steam or electric driven pumps, according to plant facilities, the location of existing power lines and the design of the lubricating system.

Air as the medium for pump operation and lubricant distribution has received considerable attention at times. In such a system specially designed lubricating pumps equipped with removable lubricant containers are installed at each point of centralized application. By connecting these pumps to a common air control device, which in turn is supplied with suitable supply and exhaust connections, compressed air, as available through any of the plant air lines, can be used to good advantage. This air is applied at regular and controlled intervals to all the lubricator pumps in the system simultaneously, to bring about delivery of a predetermined supply of lubricant to each set of gears at their point of mesh. Application or renewal of lubricant in measured quantities reduces the possibility of dripping or accumulation to a sufficient extent to cause throw-off.

By driving the air control mechanism directly from the machine to be lubricated, through suitable belt or chain connection, lubrication is only carried out during operation. In such a system comparatively heavy gear lubricants can be used, of a viscosity as high as 1000 seconds Saybolt at 210 degrees Fahr. Such products, if of straight mineral nature, will have a high degree of adhesiveness and but a very small quantity will be required to maintain an adequate protective lubricating film.

Printed in U. S. A. by
EDGAR C. RUWE CO., INC.
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(Continued from inside front cover)

Air Cylinders or Tubs	TEXACO Pelican Oil or TEXACO Altair Oil
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EXTERNAL OR MISCELLANEOUS BEARING LUBRICATION

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Motors	TEXACO Nabob or Aleph Oil
General Mill Bearings	TEXACO Black Oils
Steam Turbines	TEXACO Regal Oils
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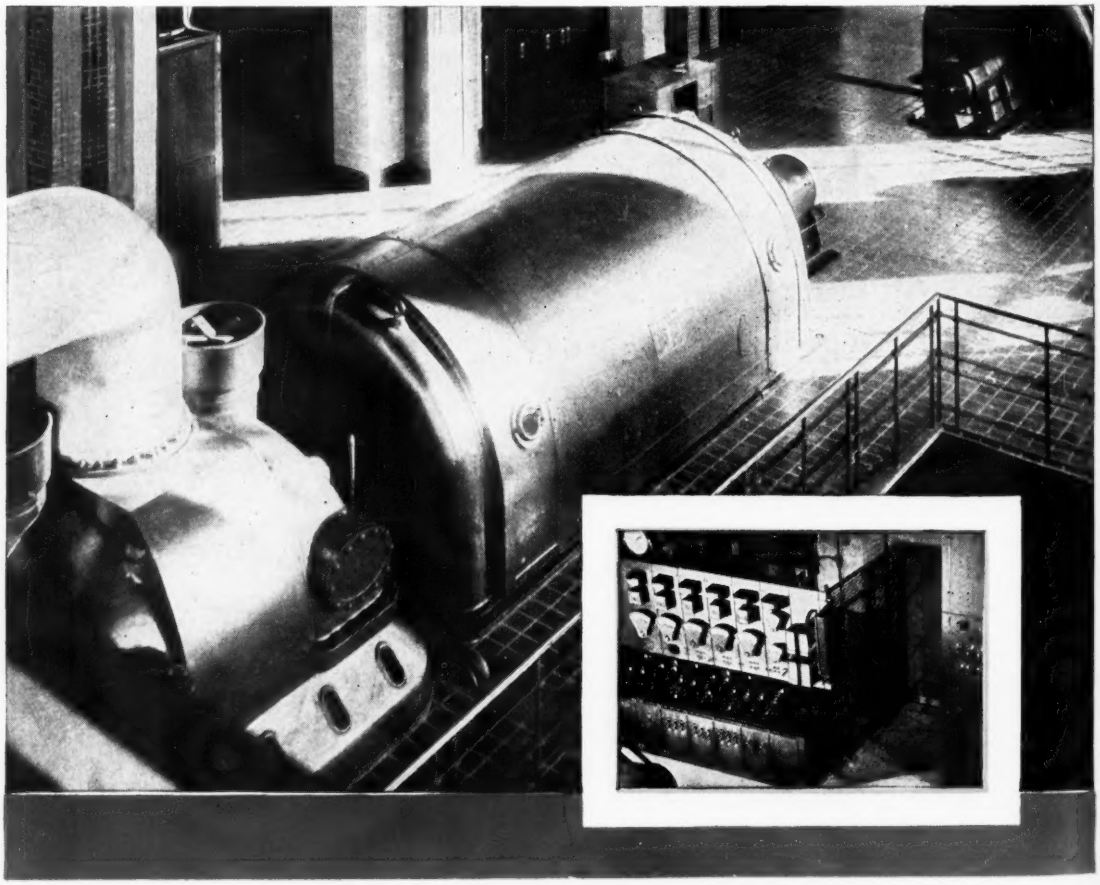
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